How one can use "The Super Farmer" game in teaching mathematical modelling and problem solving.

Agata Hoffmann
Instytut Matematyczny, Uniwersytetu Wroc³awskiego, pl. Grunwaldzki 2/4, 50-384 Wroc³aw, Poland

A few years ago, at least in my country, it was not very popular to use games in the classroom as a tool of teaching-learning process. Now, in accordance with more and more popular humanistic approach to teaching-learning process, we start to search for good examples through which we can make teacher's practice better. But there is a trap in which a lot of teachers fall. They make their lessons very attractive, but they loose the mathematical aim of these activities.

In this article I would like to present a Polish game called "The Super Farmer" and by analysing possibilities of using it with students of different ages I would like to show how teachers could make their teaching more attractive and accessible without losing the objective of improving some chosen mathematical skills.

"The Super Farmer" game was created by a Polish mathematician Karol Borsuk[1] in Warsaw in 1943. It was the time of the Second World War and selling that game (made at his home by him and his wife Zofia) was one of Borsuk's way of earning his living.

To start playing we need small cards with pictures of animals, two dice also with pictures of animals on their sides, a table of exchanging and the instruction.

From my experience I learnt that we can start playing that game with children aged from 4 years old. Of course, with such young children we have to simplify the rules and set them by ourselves. But I noticed that by practising playing that game children very quickly learn to double numbers, to count up to 3 and 6 and they unconsciously start to use functions.

When children are older, we can start using that game to improve comprehensive reading. In that case the first student's task could be reading the instruction. After that children should be ready to answer questions like those:

What is the aim of the game? What helps us to reach the aim? What are the obstacles we can meet trying to reach the aim? What can we do to avoid obstacles?

Because the answers to the above questions describe the game, I have to answer them briefly.

The aim of each player is to collect a group consisting of at least one rabbit, one sheep, one pig, one cow and one horse. The one who does it first will win!

We can collect animals in two ways – by throwing dice or by exchanging (according to the table) the animals we already possess. We start to build our collection when we receive pictures of the same animal on both dice. In that case we are able to take one of the "thrown" animals from the main collection. If we already have some animals and we are lucky to "throw" them on our dice, we are allowed to take one animal for each full pair, which we have (we count animals together with those which are on dies). The second way of enriching our collection is exchange done according to the table. Our exchanges we could do with the main collection (if there are needed animals) or with an other player (if they agree).

But the run of game is not so simple, because there is a possibility of losing animals. It takes place when we "throw" a fox or a wolf. The first of them takes all the rabbits we have, the second takes all our animals except horses and small dogs.

To help players to deal with foxes and wolves the author of the game gives us dogs – small and big ones. The former defend our collection from a fox, and the letter from a wolf. But we also know that the big dog can not defend our collection from a fox.

Now we can see that the game is quite complicated with its structure. That fact gives us an opportunity to use it on different levels. As I already said, with very young children we can just play and improve the above mentioned skills and intuitions, but with 12-year-old students we can start to examine the construction of the game – to build the mathematical model of it – and it could be very fruitful. I suggest we should start it by exploring the materials given to play the game – cards, dice and the exchange table.

[1] Karol Borsuk (1905-1982) Polish mathematician – topologist, the creator of the theory of retracts and the theory of shape.

We can start with questions connected with given cards with pictures of animals. We know that altogether there are 128 pictures and there are different numbers of different pictures – 60 with rabbits, 24 with sheep, 20 with pigs, 12 with cows, 6 with horses, 4 with small dogs and 2 with big dogs. The questions which could help students to analyse a situation created by that are:
Why was this kind of division chosen? What could happen if the division were be different (for example if the number of cards with pictures of each animal were the same – 60 or 11 or 2)?
Is the total number of cards with pictures related to the suggested number of players – 2 to 6?
Why are there no pictures with a fox and a wolf? What are the consequences of the chosen number of dogs?

The next tool are dice – a red and a yellow one. Both are in the shape of one of regular polyhedras – a dodecahedron. On each side of these dodecahedrons there is a picture of one animal. Some questions which could help students to analyse a situation created by that are:

Is the colour of the dice the only difference between them? What are the consequences of that?
Is the shape (being a regular polyhedra) important to the game?
Is the way of putting animals on sides of dice important to the game?
What kind of combinations of animals could we receive by "throwing" two dice?
Is there any connection between the number of cards with pictures of each animal and the number of animals put on dice?

The last tool used is the exchange table. It tells us proportions in which we can make exchanges. Some questions which could help students to analyse a situation created by that are:
What is the hierarchy of value of animals? Why? Is there any connection between set proportions in the table and the numbers of cards with pictures of animals? Is there any connection between set proportions in the table and the numbers of pictures of animals on the dice?

When we answer these questions we will be prepared to start to examine the construction of the game – to build the mathematical model of it. But, of course, now more questions come to our minds. They are like those:
Do we enrich ourselves with the same speed when we decide to concentrate on collecting animals of one chosen kind? Is the strategy of gathering one kind of animal fruitful? Why?
Are we able to complete all collection without making exchanges? Why? How dangerous are for us the fox and the wolf? Is it good to collect dogs? Is there any strategy which guarantees winning?

With the last question we open the most advanced level of considering the presented game. With students who know something about probability we could answer questions like those:
What are the possible outcomes in "throwing" dice? Are the possible outcomes equally likely?
What is the probability of starting our collection with a rabbit? What about other animals?
What is the probability of "throwing" a fox? What about a fox and a wolf together?
What is the probability that we can throw a pig under the condition that we also throw a horse?
What is the smallest number of "throwing" dice needed to win the game?

But even now we can vary the level of knowledge we needed to answer these questions. After that kind of exercise I think that students could pose and answer their own questions connected with that game and the mathematical model of our game becomes more and more complete.

In teaching-learning mathematics there are a lot of very important aspects. Teachers should take care of all of them, but their work would be complete chaos if they tried to do everything at the same time. In their everyday practice, they have to select goals they will concentrate on one day and combine them using the chosen tool in the best possible way to obtain the main goal – a well-educated student. In that kind of work teachers not only need a lot of examples of tasks but they also need an opportunity of having discussions how to use them.

In my presentation I described an example of both those things. I chose two abilities as mathematical goals I would concentrate on – comprehensive reading and mathematical modelling. Then I chose the tool with which I would like to obtain my goals –"The Super Farmer" game. I gave also examples of posed questions which could help students to reach the chosen mathematical aims.

This game is so well-constructed that we could use it with students aged form 4 to 20 years old. Of course, with each age group we will concentrate on different problems.

I think that making teachers or future teachers aware of this kind of examples is very important and will help them in their future work.